

# Shasta River Watershed TMDLs

Meeting of the Technical Advisory Group  
and Interested Parties

November 3, 2005



# Purpose of Meeting

- To review why we are developing TMDLs and review components of a TMDL
- To present Shasta River TMDL results
- To discuss components of Shasta River TMDL Implementation Plan
- To get your input/feedback and answer your questions
- To identify next steps in process

# Outline

- Introductions
- TMDL background/framework
- Conceptual models and analytical approach
- Temperature and dissolved oxygen TMDL findings
- Implementation Plan components discussion
- Next steps in process
- Feedback – Q &A

# Introductions

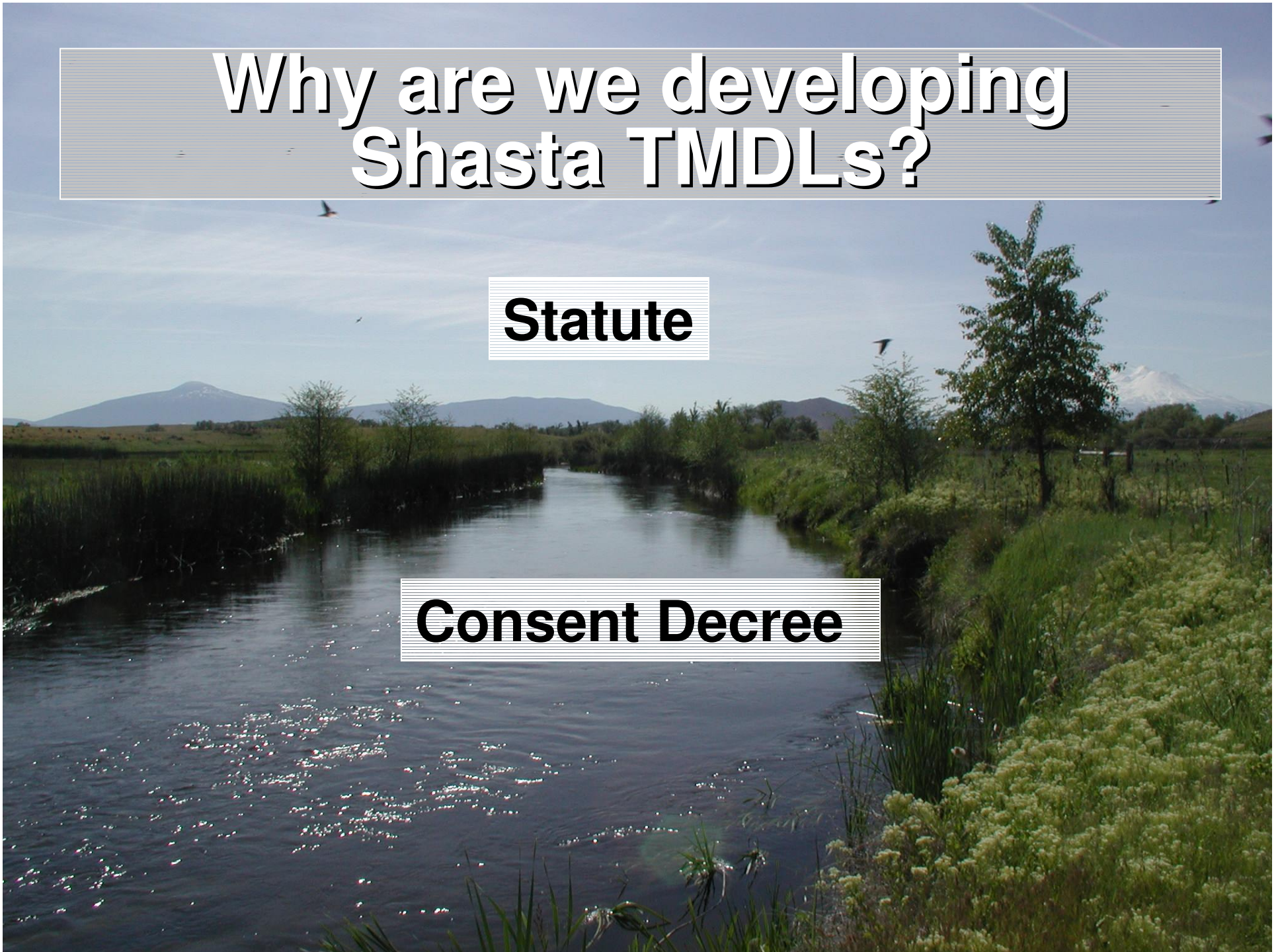




# Why are we developing Shasta TMDLs?

**Statute**

**Consent Decree**





# Legal Basis for Shasta TMDLs



**Statute**

**Consent Decree**

**Federal Clean Water  
Act §§ 301-308  
(adopted 1972)**

- 1. Identify surface waters not meeting water quality standards**
- 2. Develop TMDLs**
- 3. Adopt TMDLs in the Basin Plan**



# Legal Basis for Shasta TMDLs

**Statute**

**Consent Decree**

**14 Plaintiffs sued the U.S. EPA to compel TMDL development in North Coast**

**Consent Decree in 1997 resulted in timeline to complete TMDLs**





# **TMDLs – 1997 Consent Decree**

**All Consent Decree waterbodies must have TMDL established by 2007.**

**Shasta TMDLs must be adopted by Regional Water Board in 2006.**



Oregon

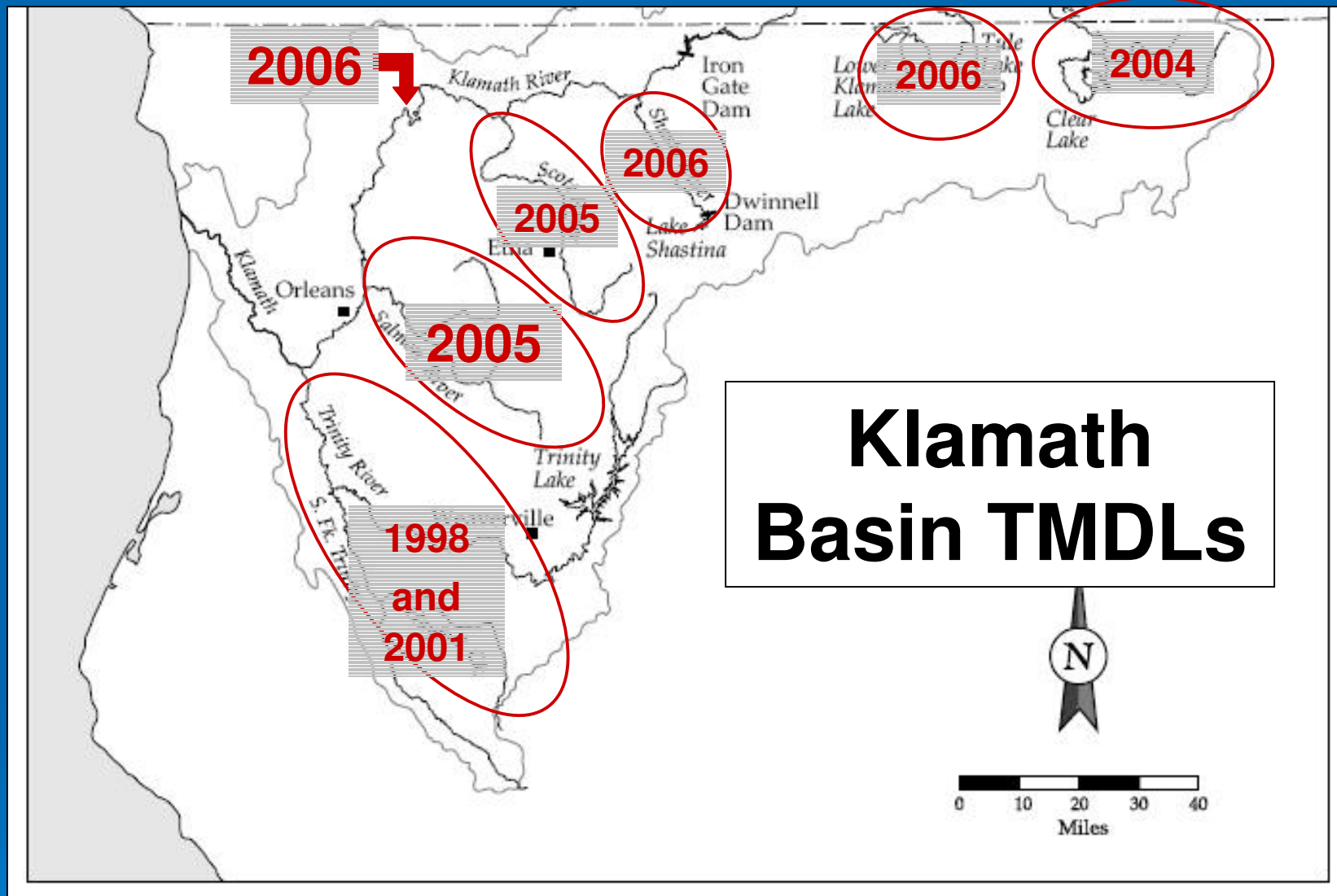
Shasta  
River

**NCRWQCB (Region 1)**

California

0 10 20 40 60 Miles





**Tributary completions precede mainstem Klamath TMDL**



# Shasta River Impairments

- Organic enrichment / low dissolved oxygen – 1992
- Elevated stream temperature – 1994
- Cold water fishery
- Recreational use
- Municipal and domestic water supply

# What is a TMDL?

**Total Maximum Daily Load**

**Amount of a pollutant that a waterbody can receive and still attain & maintain WQS**

**WQS are water quality objectives plus beneficial uses**

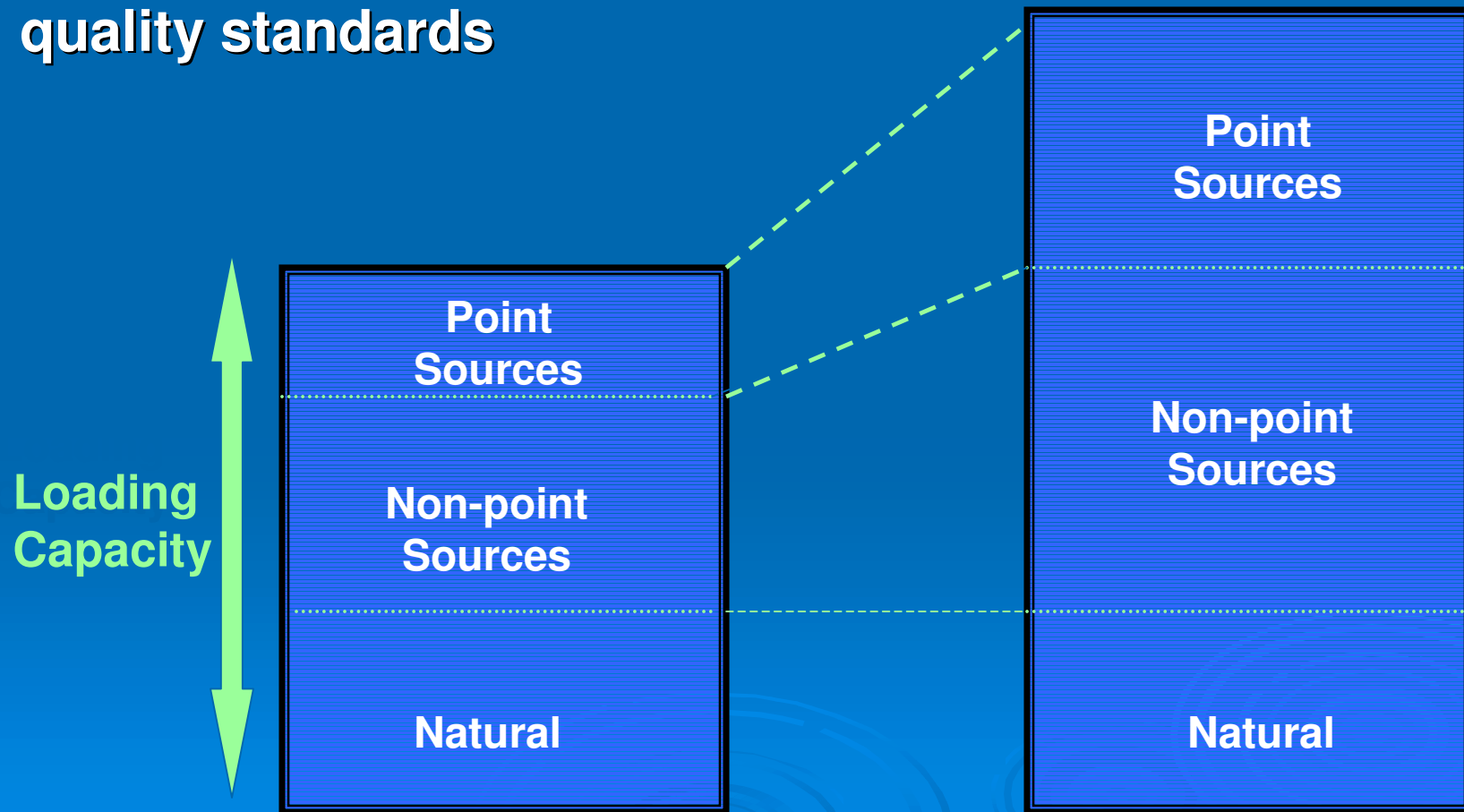




# A TMDL is a framework for:

- Evaluating and quantifying the factors that contribute to water quality problems
- Developing a strategy (called an Action or Implementation Plan in CA) to attain water quality standards

**A TMDL develops a pollution budget and a strategy so that the two boxes become equal; it represents the amount of pollution the waterbody can receive and still meet water quality standards**





# Components of a TMDL

A photograph of a rural landscape. In the foreground, there is a field with low-lying green and greyish vegetation. Several brown and black cows are grazing in the field. A thin wire fence runs across the lower part of the image. In the middle ground, a river flows through the landscape. The background features rolling hills and mountains under a clear blue sky.

**Technical TMDL Analysis**

**Implementation Plan**

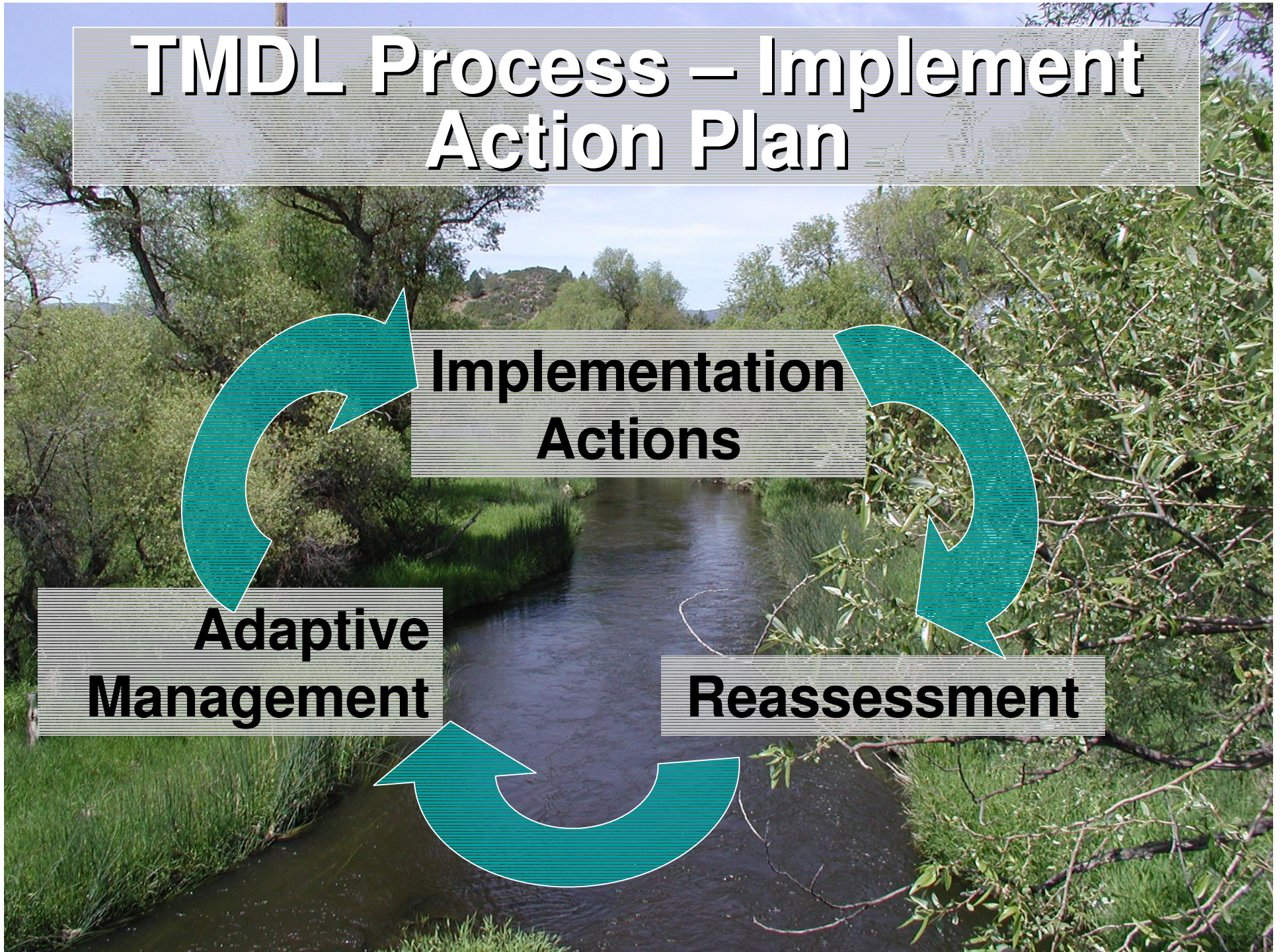


# TMDL Process – Implement Action Plan

**Implementation  
Actions**

**Adaptive  
Management**

**Reassessment**



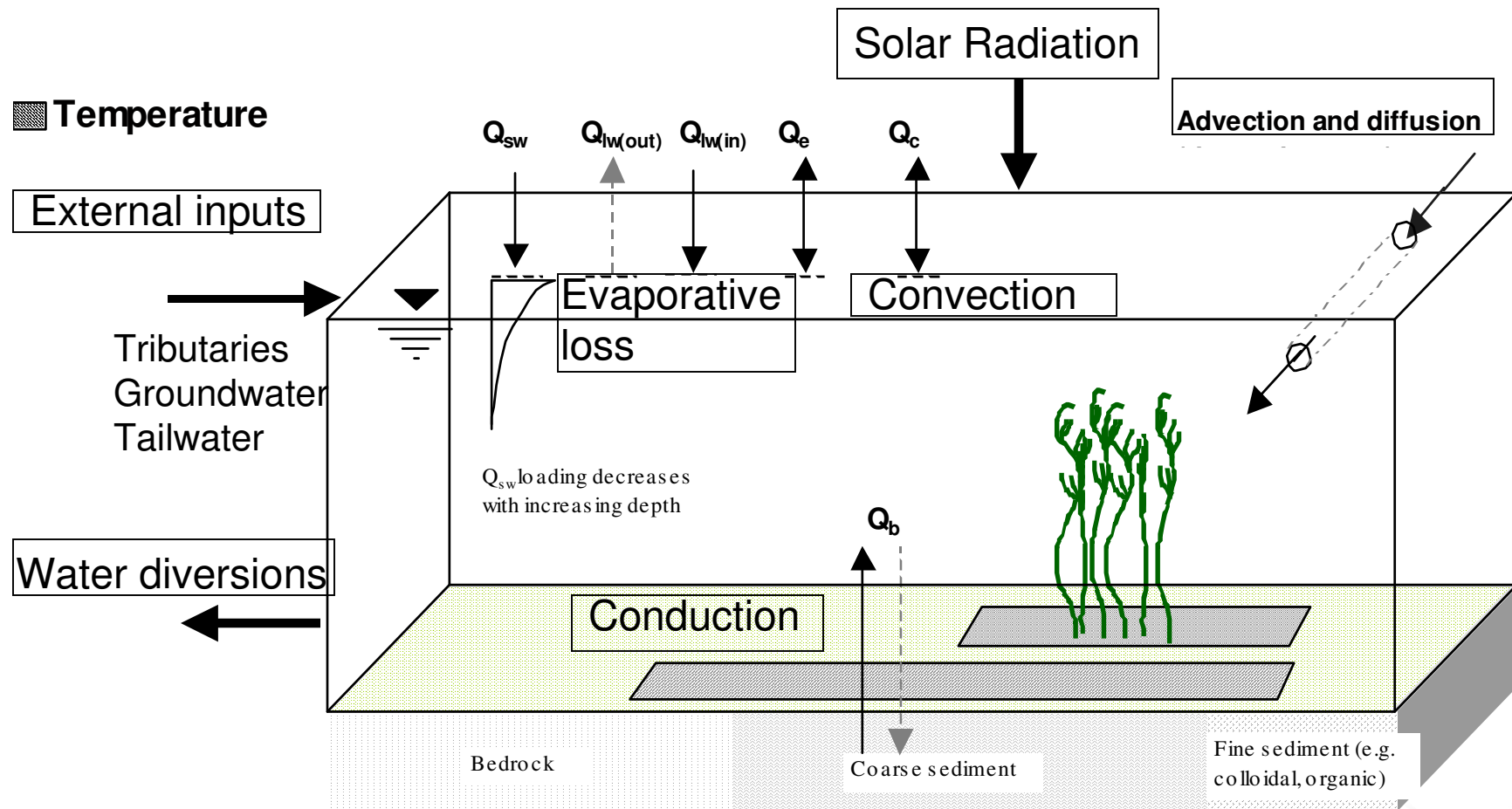


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# Water Temperature Processes

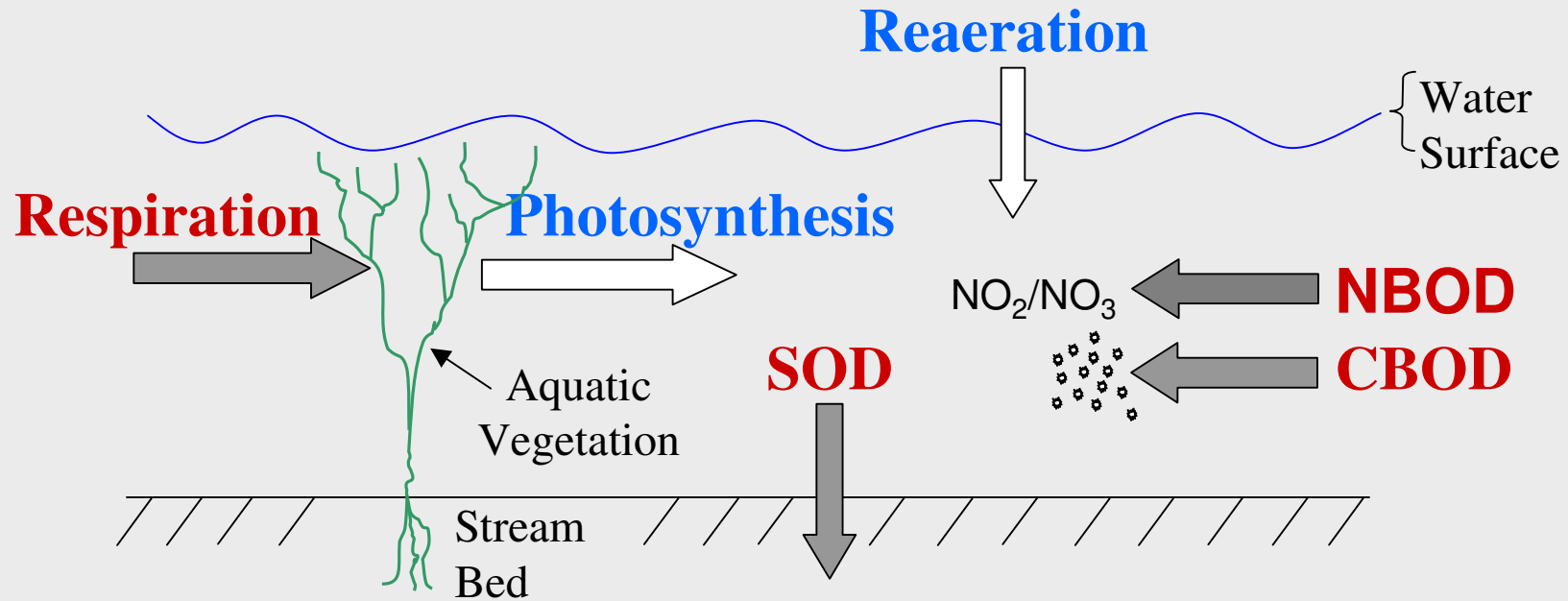


# Factors affecting Shasta River temperature:

- Solar radiation and shade
- Tailwater return flow inputs
- Surface water diversions
- Spring inflows
- Impoundments

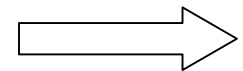


# Processes Affecting Dissolved Oxygen



## Dissolved Oxygen Sources

- Reaeration
- Photosynthesis



## Dissolved Oxygen Demands

- Respiration
- Sediment Oxygen Demand (SOD)
- Carbonaceous Deoxygenation (CBOD)
- Nitrogenous Oxygen Demand (NBOD)





# Factors affecting Shasta River dissolved oxygen levels:

- Temperature
- Photosynthesis and respiration of aquatic plants; affected by:
  - Temperature
  - Light (shade and water clarity)
  - Nutrients
- Sediment oxygen demand
- Inputs of organic material (CBOD) and nutrients (NBOD)

# TMDL development approach

- Developed monitoring plan to test working hypotheses
- Monitoring and assessment
- Empirical data analysis
- Application of TVA River Modeling System and supporting models – “Tool Box”

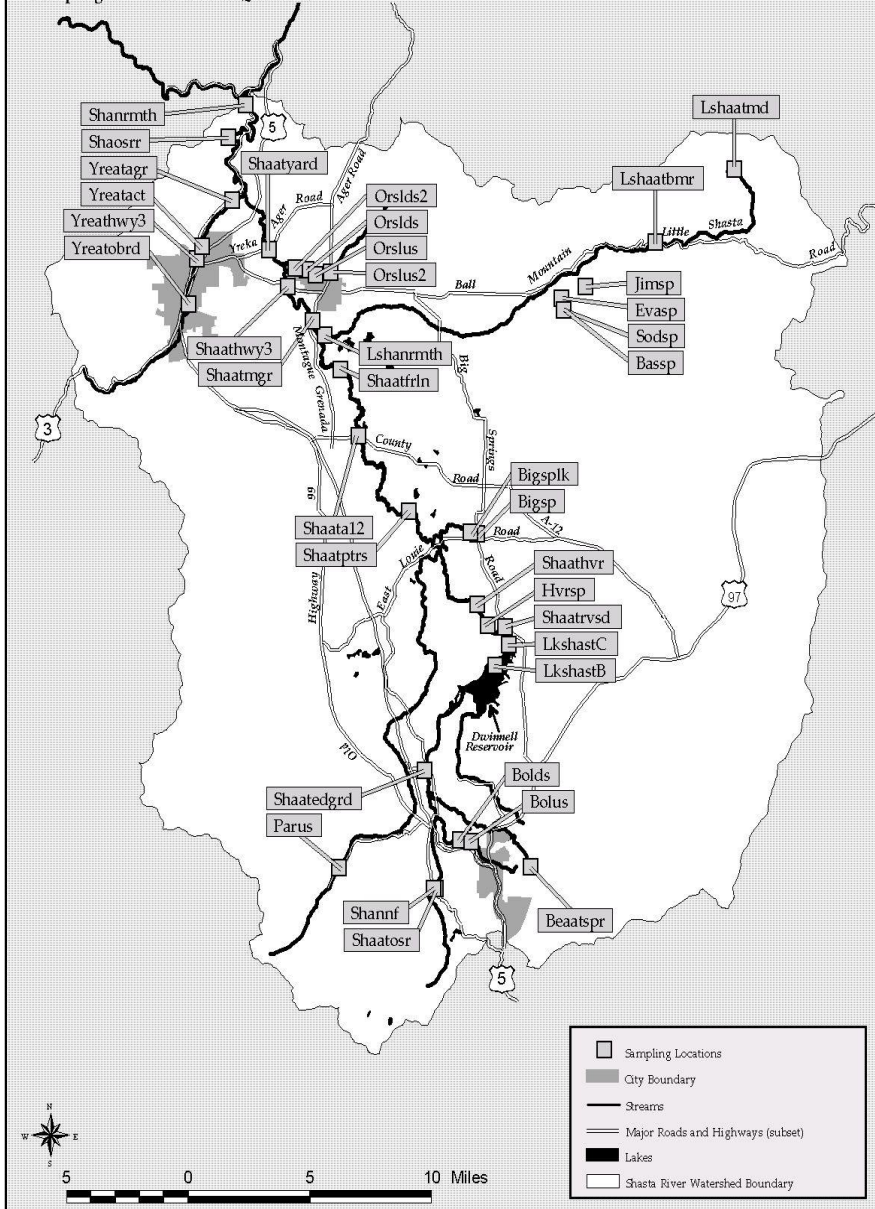
# Analytical Toolbox

- Objective: compliment RMS in the assessment of water quality
- Toolbox
  1. Benthic Algae Model
  2. Mass Balance
  3. Residence Time
  4. Mixing Model
  5. Primary Productivity Calculator



**Figure 1. Shasta River Watershed**

(Sampling Locations - NCRWQCB 2003)



## Monitoring / Assessment Overview:

- Hourly DO measurements at 16 sites
- Hourly temperature measurements at 19 sites
- Grab samples at 42 sites
- SOD measurements at 18 sites
- Aquatic vegetation survey of 27 miles of river plus Shastina
- Stream bottom substrate characterization at 20 sites
- Riparian vegetation classification of 27 miles of river
- Flow measurements at 9 sites
- Thermal infrared survey of Shasta River and key tributaries
- Stable isotope samples from 21 sites

# Available Work Products

<http://www.waterboards.ca.gov/northcoast/programs/tmdl/shasta/shasta.html>

- Shasta River Dissolved Oxygen TMDL Work Plan (NCRWQCB 2003)
- Shasta River Water Quality Conditions – 2002 & 2003 (NCRWQCB 2004) and (USGS 2004)
- Shasta River Water Quality Related Investigations – 2004 (NCRWQCB 2004)
- Thermal Infrared Study (Watershed Sciences 2004)
- Lake Shastina Limnology (Watercourse 2005)

# Shasta River Modeling

- TVA RMS: Extension of Abbott (2002) and Deas (2003) to include:
  - Dissolved Oxygen
  - Forcing Functions
    - Biochemical Oxygen Demand
    - Nitrogenous Oxygen Demand
    - Sediment Oxygen Demand
    - Attached Algae Standing Crop
  - Updated geometry – flow, water quality, and shade representation
  - Extended from Dwinnell Dam to mouth



# Modeling Tasks

- Calibration and validation
- Sensitivity testing
- Scenarios
  - Objective: To determine a suite of conditions that result in water quality standards attainment under critical conditions
  - “Water quality compliance” scenario

# Water quality compliance scenario conditions:

- Increased riparian shade
- Reduced inflow temperatures
- Reduced aquatic plant standing crop
- Reduced SOD rates
- Reduced NBOD inputs



# Water quality compliance scenario conditions:

- Increased riparian shade:
  - Decreased percent transmittance
  
- Reduced inflow temperatures:
  - Big Springs Creek (Baseline minus 4 °C)
  - Parks Creeks (Baseline minus 2 °C)
  - Tailwater return flows (= river temperature)
  
- Reduced aquatic plant standing crop:
  - 50% reduction in photosynthetic and respiration rates

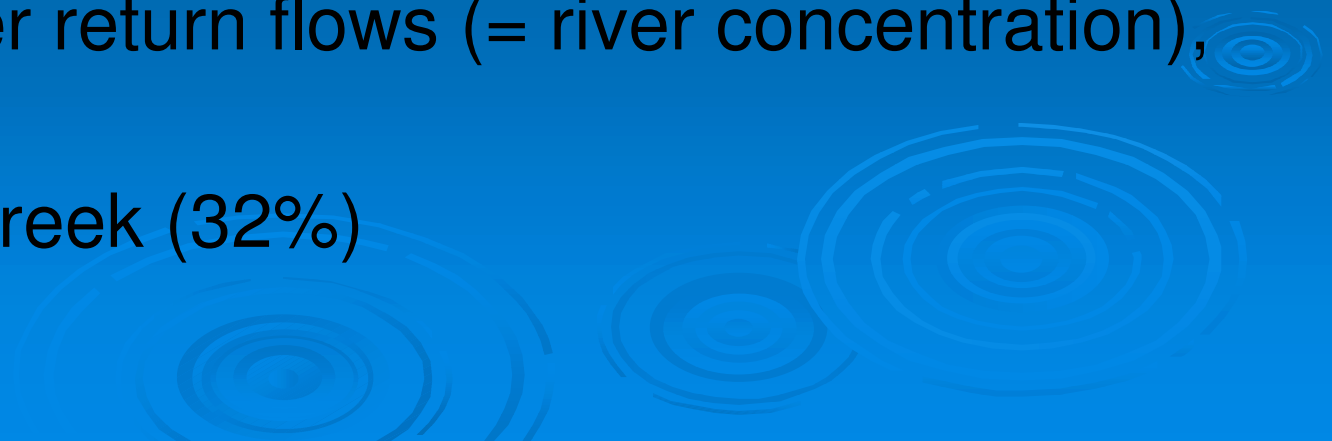


# Water quality compliance scenario conditions:

## ➤ Reduced SOD rates:

- 50% reduction of SOD rates behind impoundments

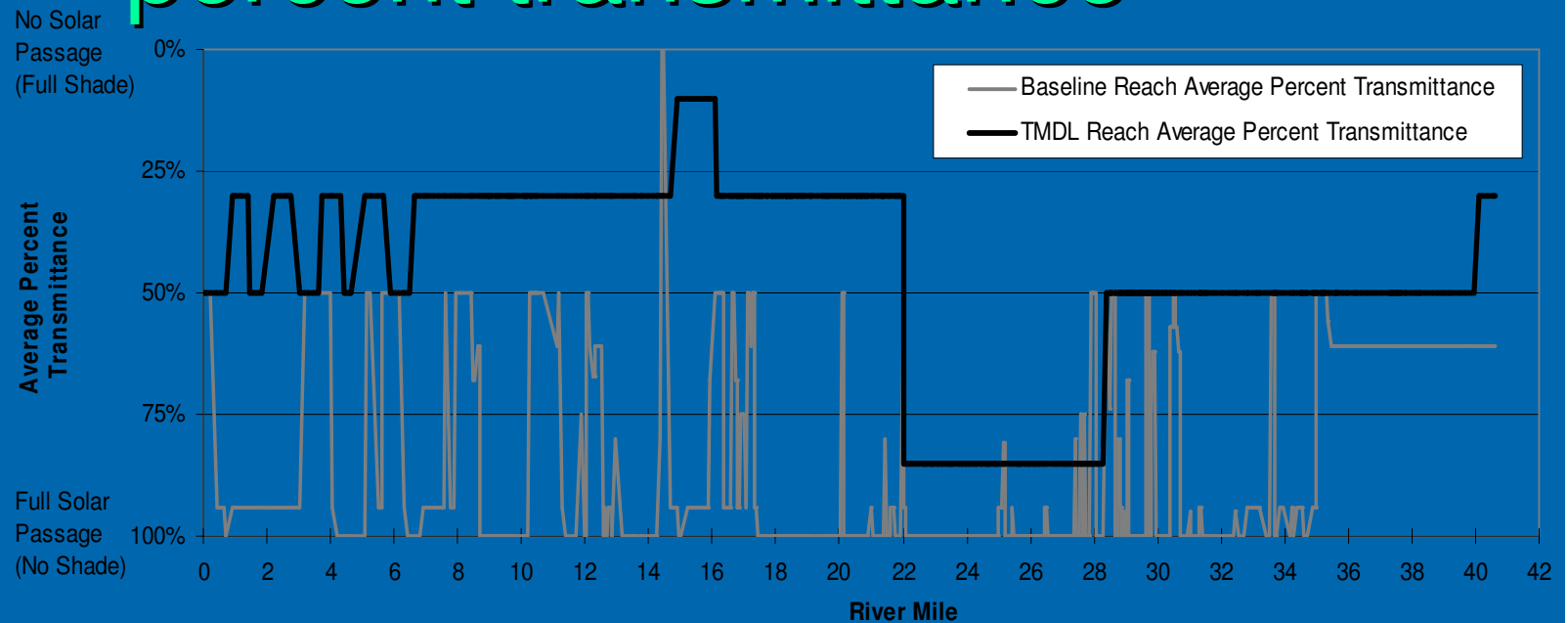
## ➤ Reduced NBOD input concentrations:

- Dwinnell Dam (67%),
  - Tailwater return flows (= river concentration), and
  - Yreka Creek (32%)
- 

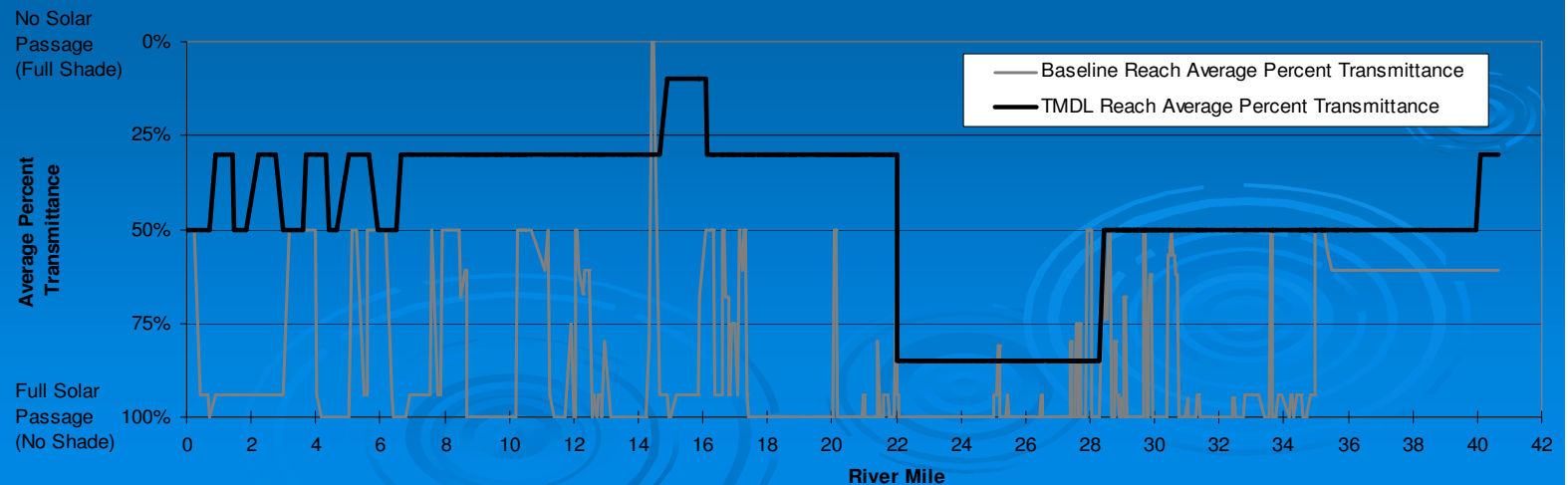


# Baseline versus estimated potential percent transmittance

**Left Bank**



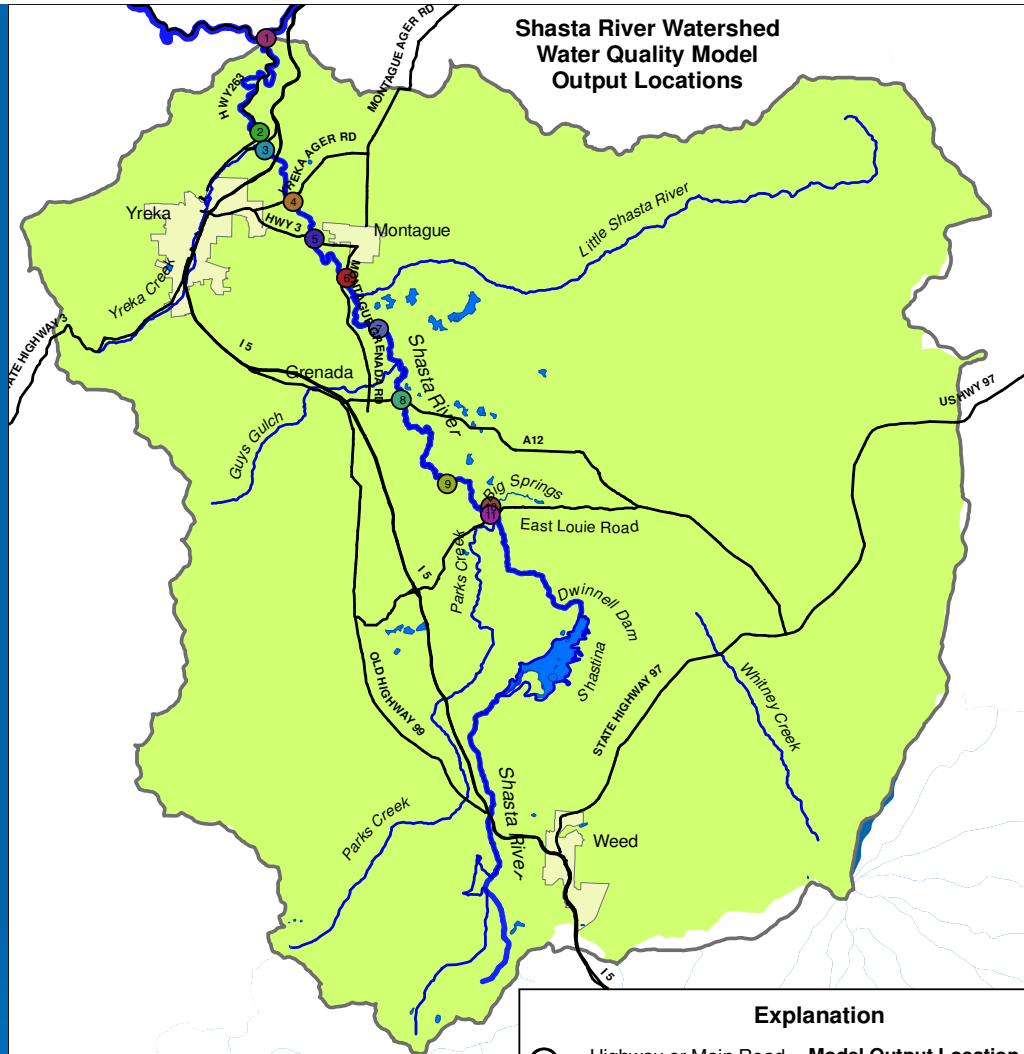
**Right Bank**



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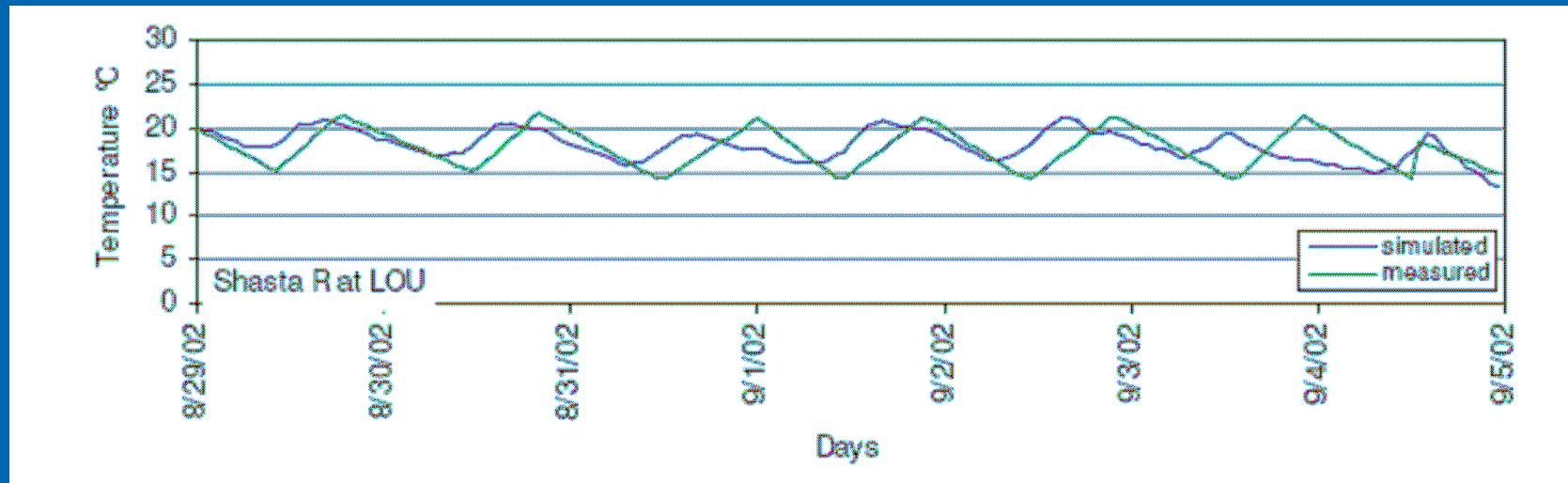
# Shasta River Watershed Water Quality Model Output Locations



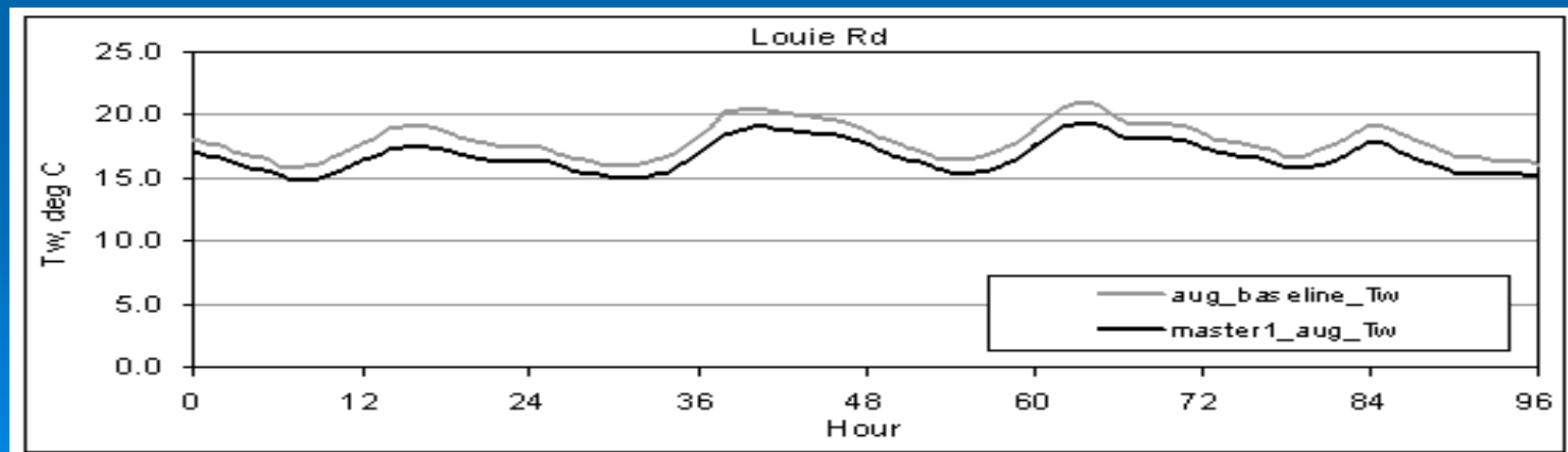
Explanation	
	Highway or Main Road
	Urbanized Area
	Klamath River
	Shasta River Main Stem
	Major Tributary
	Lake
<b>Model Output Location</b>	
	1. Mouth
	2. Hwy 263
	3. Anderson Grade Road
	4. Yreka-Ager Road
	5. Hwy 3
	6. Montague Grenada Road
	7. Freeman Road
	8. A-12
	9. GID/Hueseman diversion
	10. Big Springs Cr
	11. East Louie Road

Map prepared by Bruce Gwynne; NCRWQCB  
e mail: bgwynne@waterboards.ca.gov  
telephone: 707-576-2661

# Model Results - Temperature

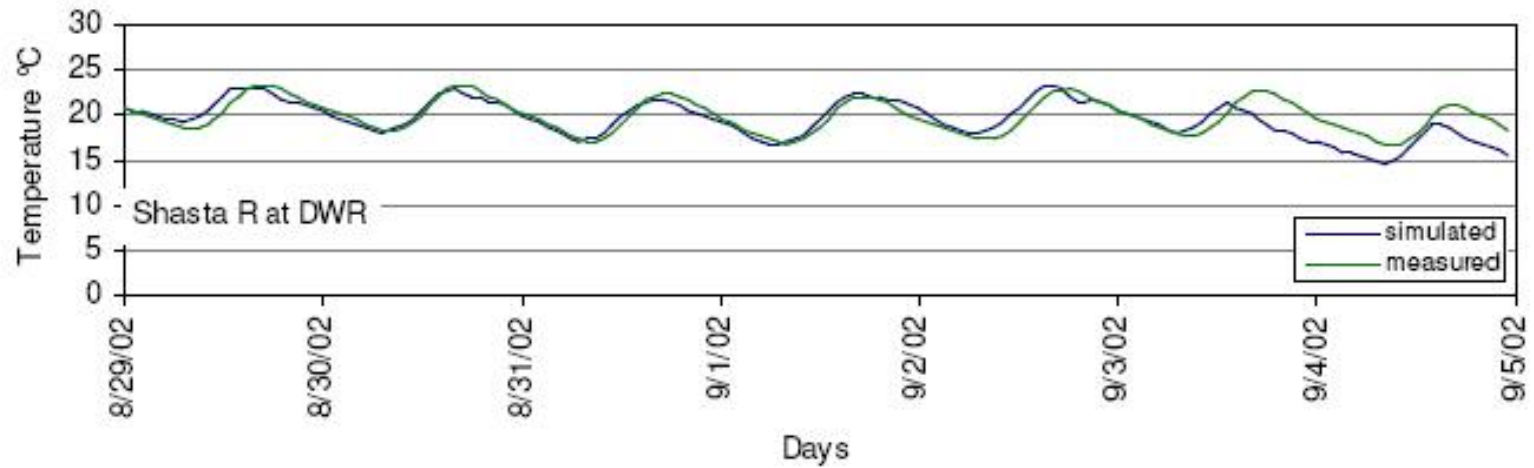


Louie Road - Calibration

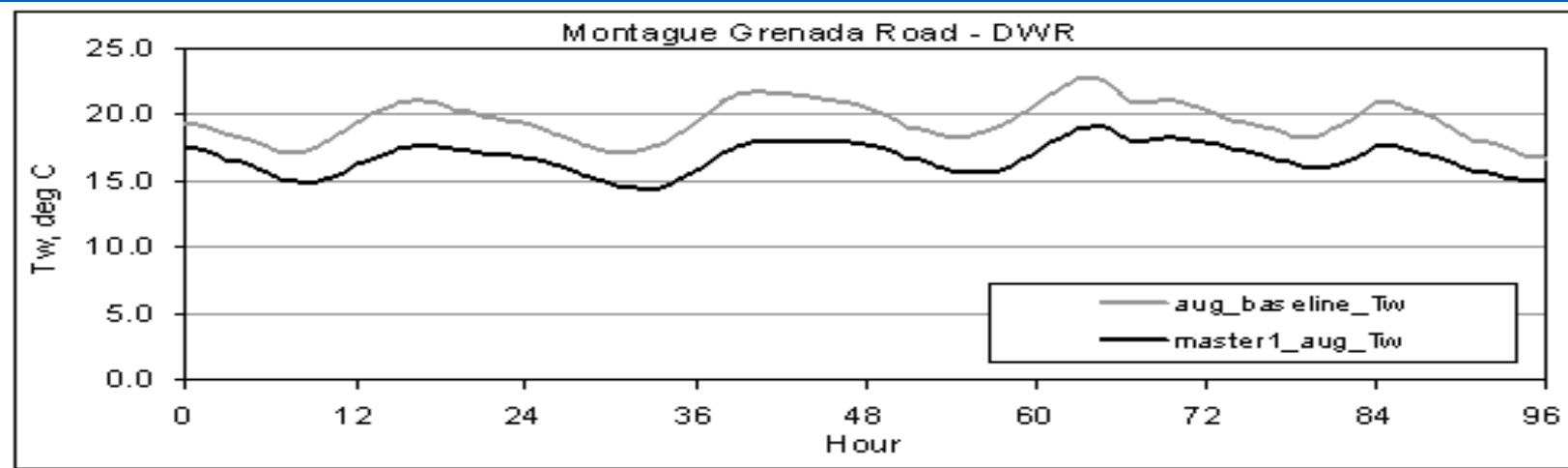


Louie Road - WQ Compliance

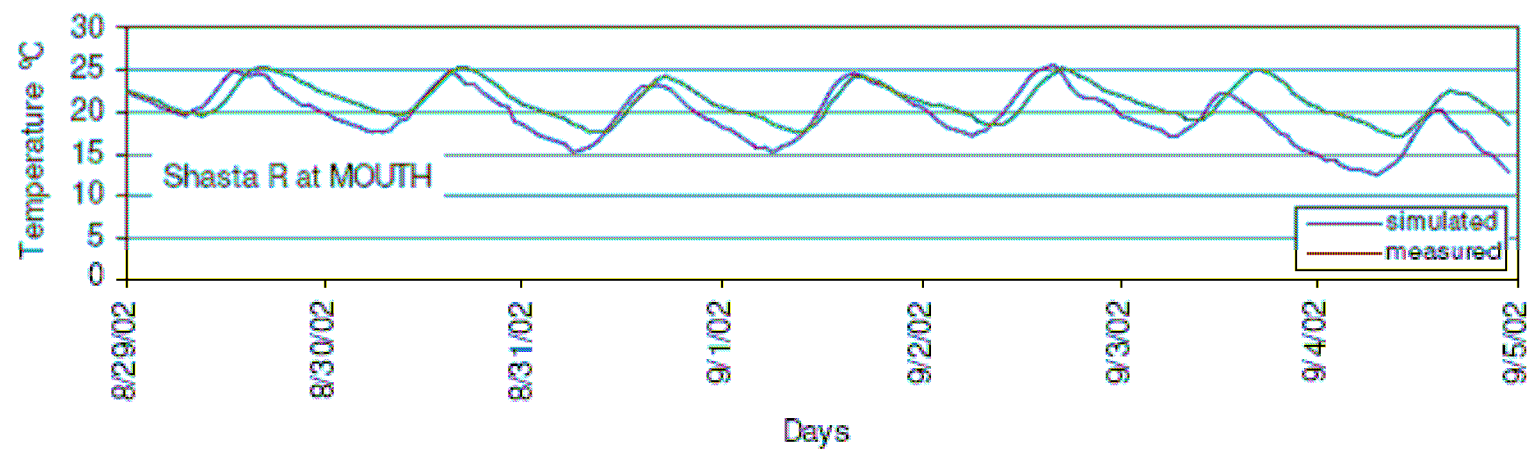




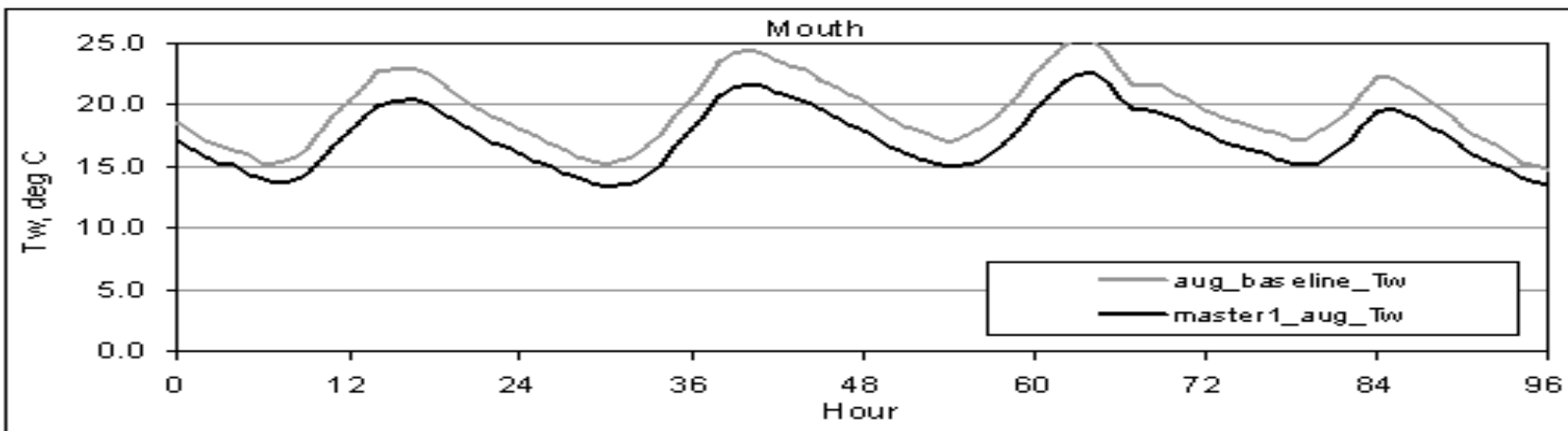
Montague-Grenada Road - Calibration



Montague-Grenada Road - WQ Compliance




Mouth - Calibration



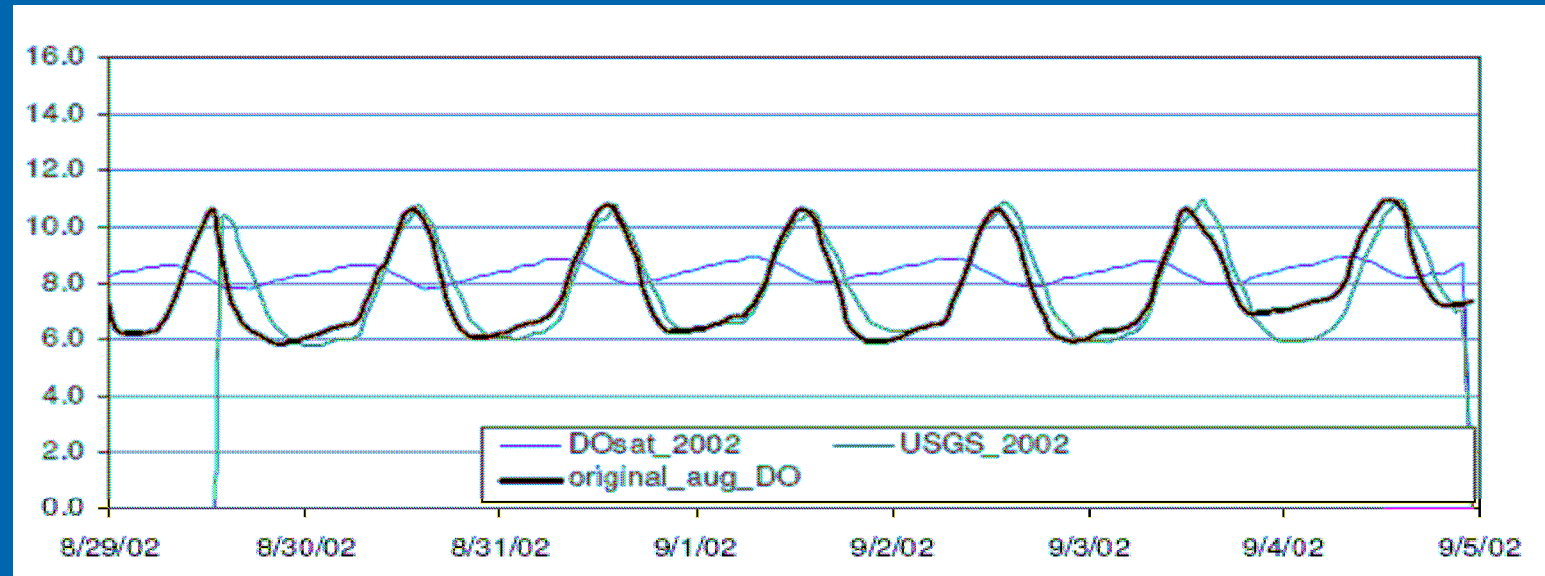
Mouth - WQ Compliance

# Temperature Results Summary

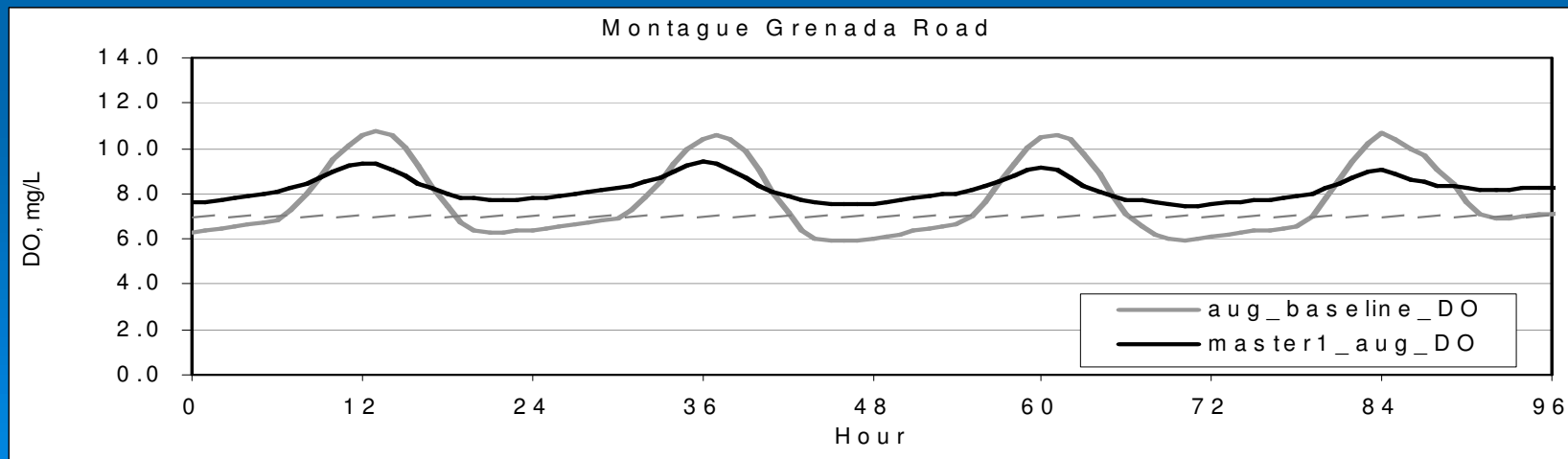
- Temperatures decreased at all river locations during each simulation period
  - 1 °C – 4.5 °C decrease from baseline
  - Greatest decrease around GID, Hwy 3, and Y-A Road
  - On average, temperature decreases are largest in August
- 



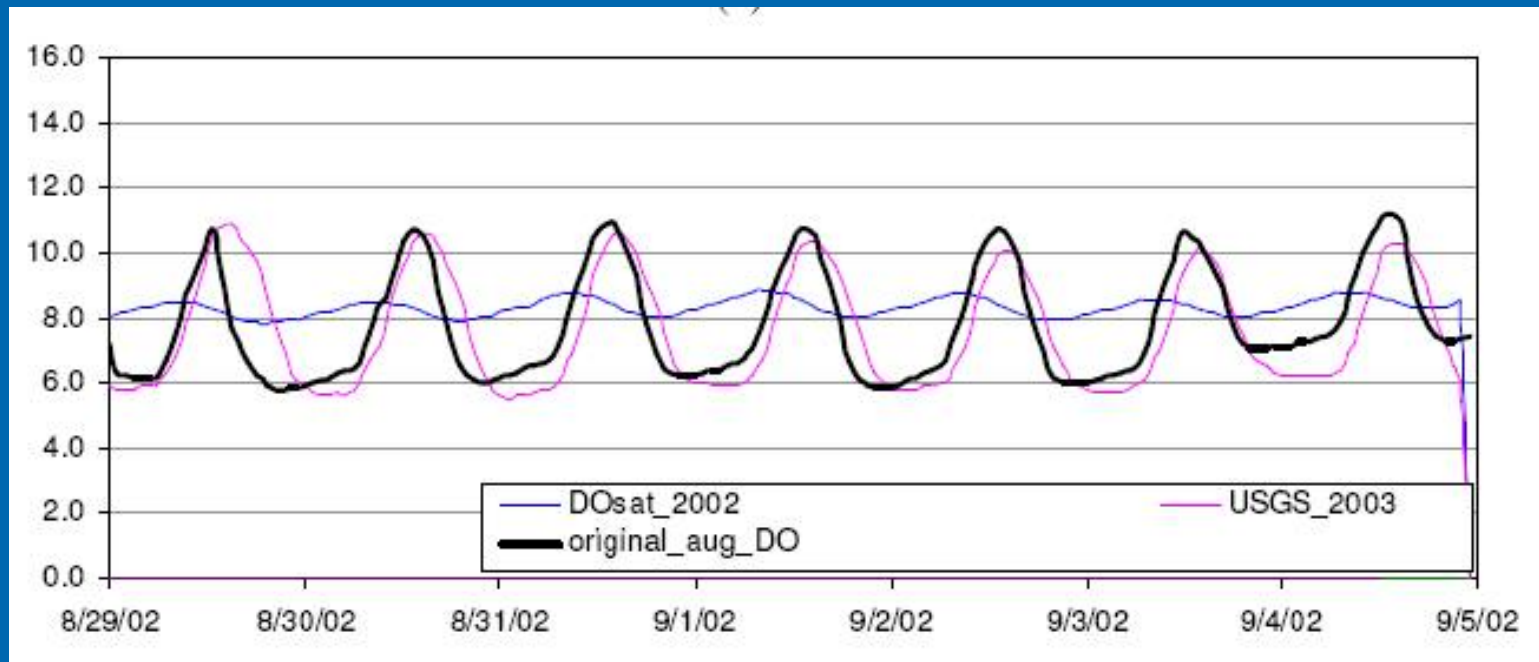
# Model Results – Dissolved Oxygen



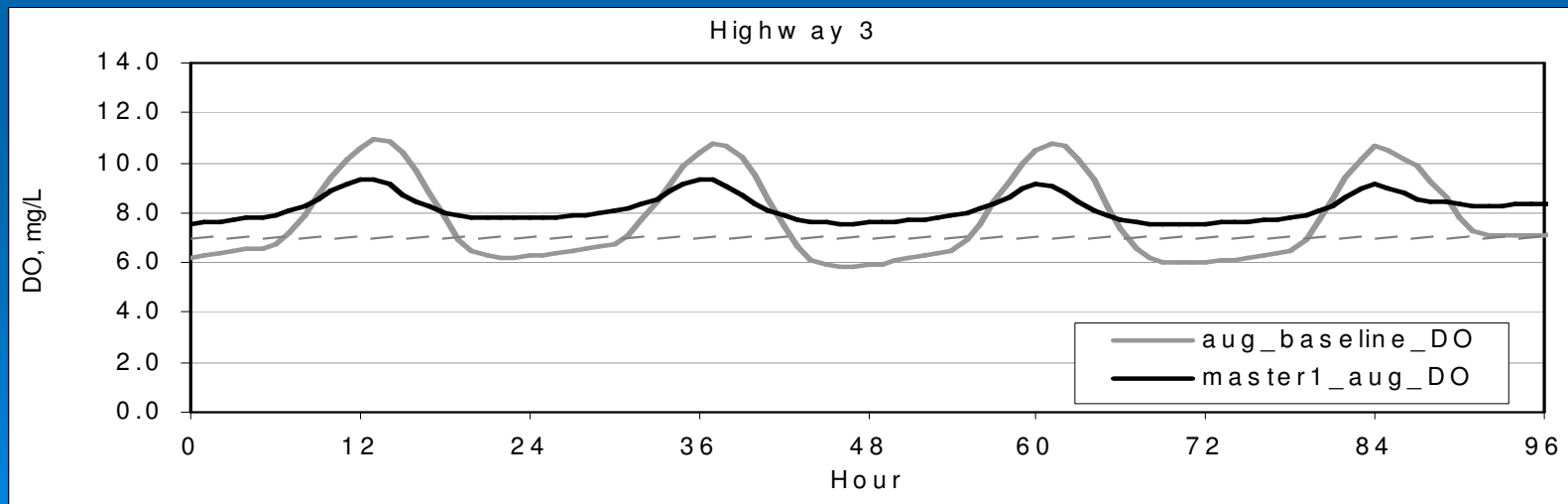
Montague-Grenada Road - Calibration



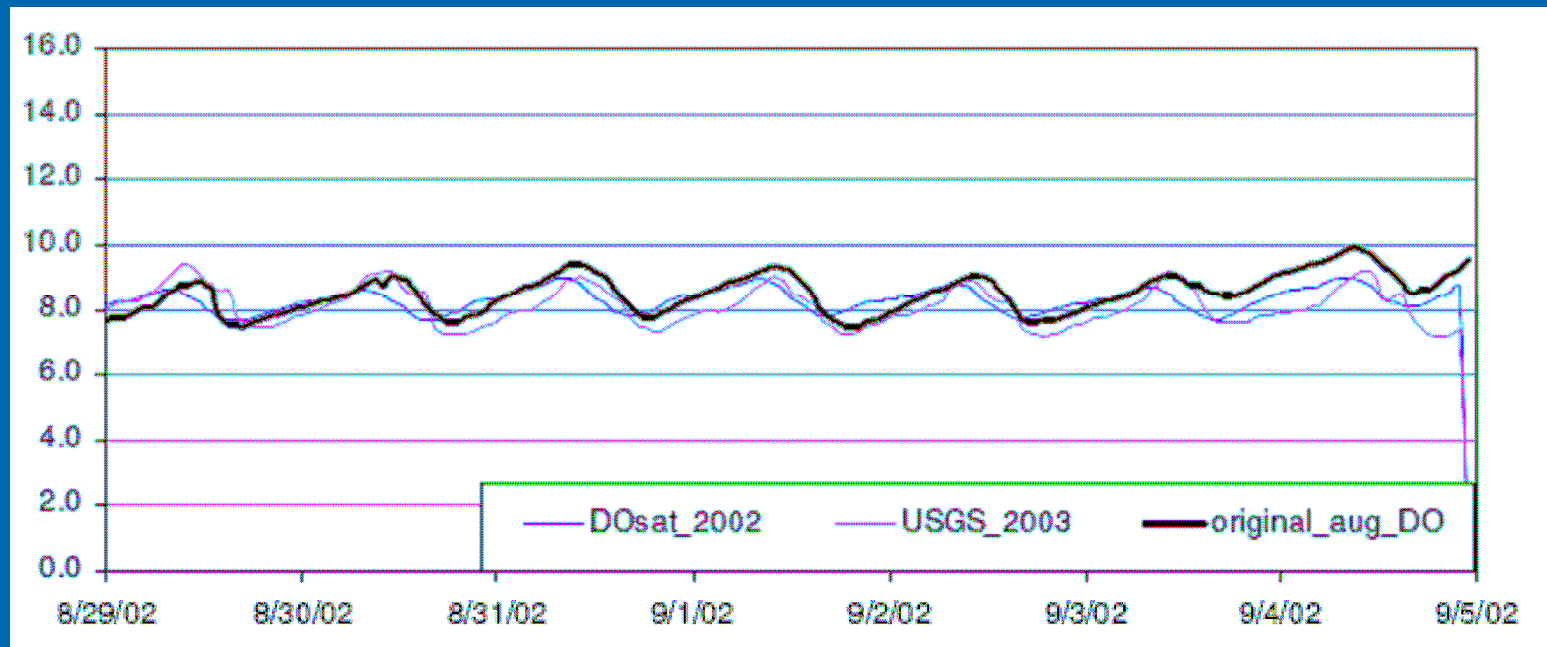
Montague-Grenada Road - WQ Compliance



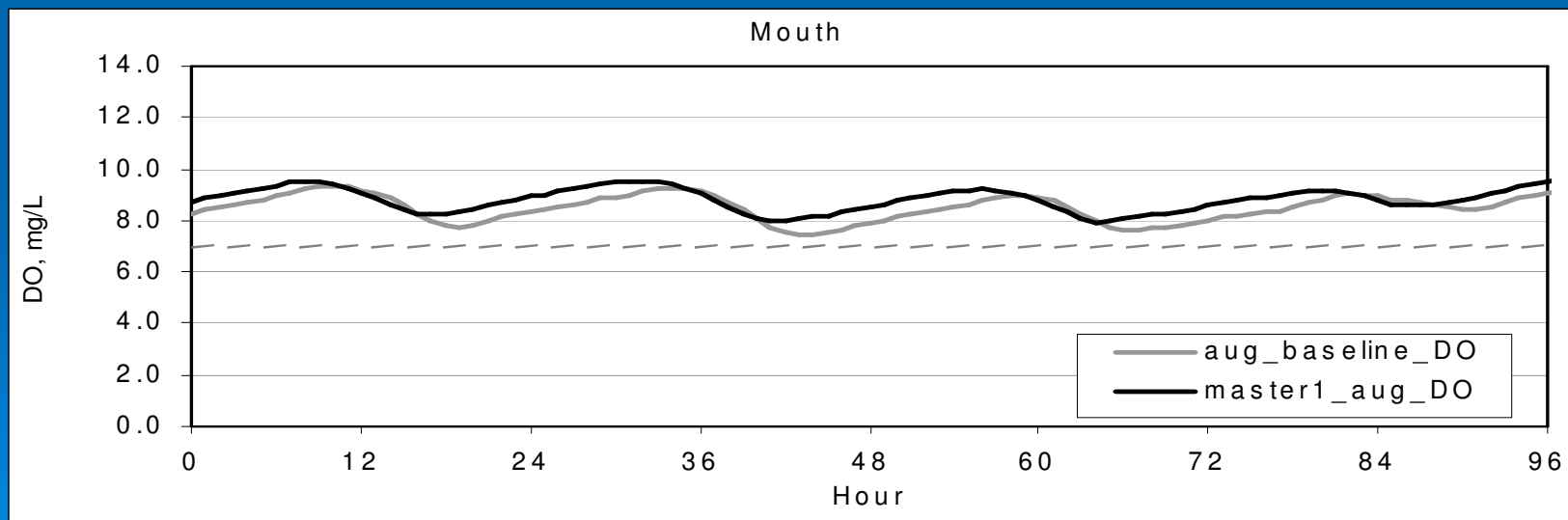
Highway 3 - Calibration



Highway 3 – WQ Compliance



Mouth - Calibration



Mouth - WQ Compliance

# DO Results Summary

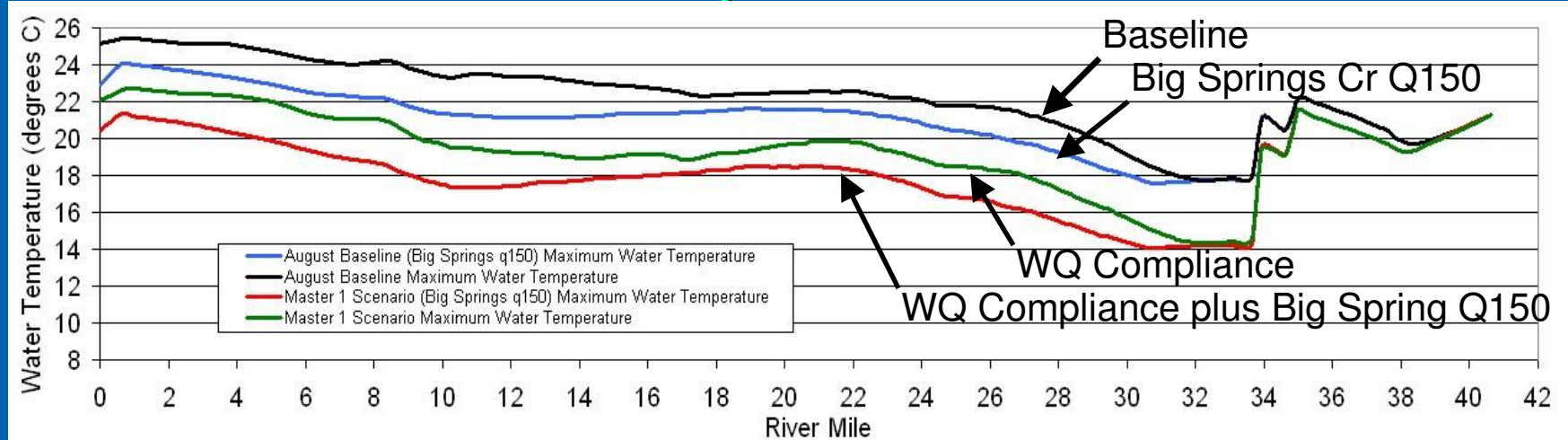
- Magnitude of DO fluctuations reduced at all locations
- Minimum DO concentrations increased to above 7.0 mg/L at all locations
- Minimum DO concentrations increased by 0.5 mg/L to 2.0 mg/L; average increase of 1.5 mg/L
- Greatest increase in minimum DO concentration at GID and Hwy A12



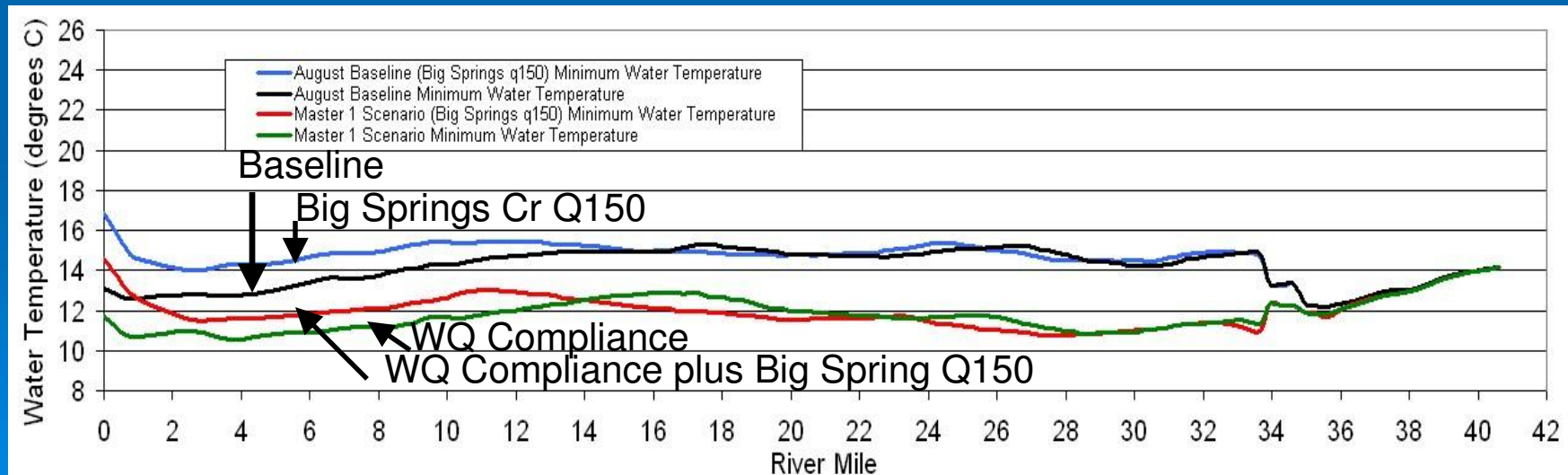
# Flow Increase Scenarios

- Objective: Evaluate affect of flow increases on temperature and DO
- 1. Increased Shasta River baseline flows by 50% at Dwinnell Dam, Big Springs Creek, GID, Hwy A12, M-G Road, and A-G Road; applied in step-wise fashion
- 2. Combined increased flows with water quality compliance scenario conditions

# Big Springs Creek 150% Flow Scenario Results - Temperature



Maximum Temperatures



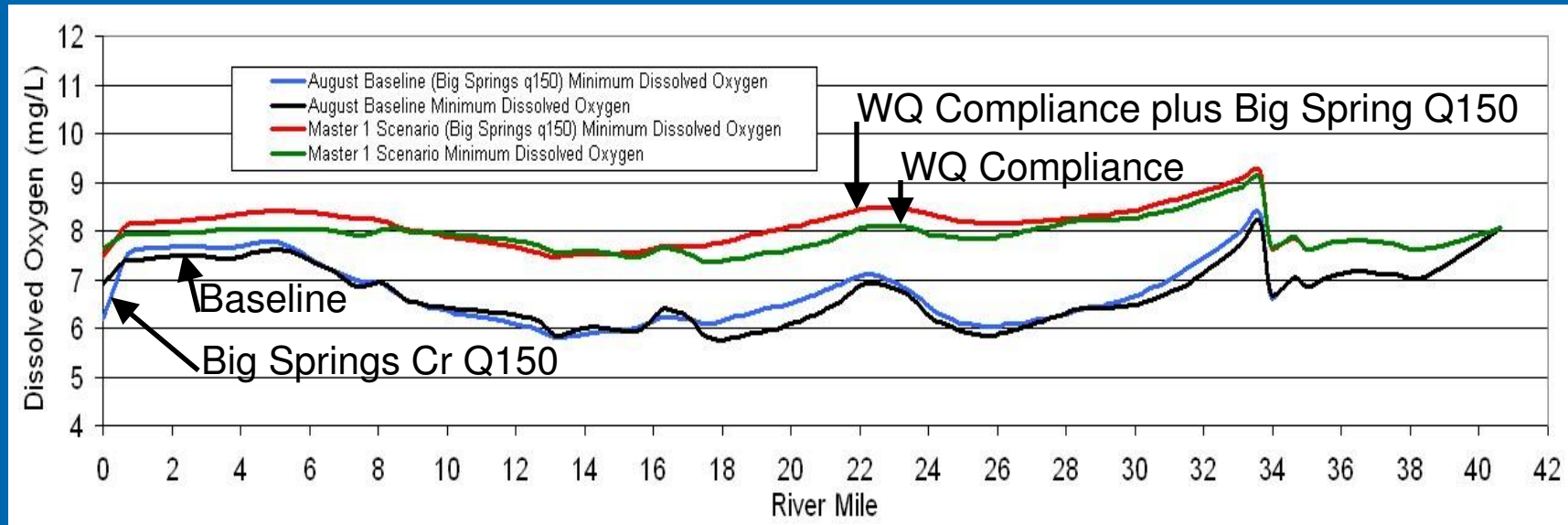
Minimum Temperatures

# Increased Flow Scenarios – Temperature Summary

- 50% flow increases result in reductions in maximum stream temperatures at all river locations
- Maximum stream temperatures decreased by 0.1 °C to 2.4 °C
  - Largest reduction at Anderson-Grade Road of 2.4 °C due to 150% Big Springs Creek flow plus WQ compliance conditions
- Effect on minimum stream temperatures mixed
  - Largest reduction at M-G Road of 0.7 °C due to 150% Big Springs Creek flow plus WQ compliance conditions



# Big Springs Creek 150% Flow Scenario Results Dissolved Oxygen



Minimum Dissolved Oxygen

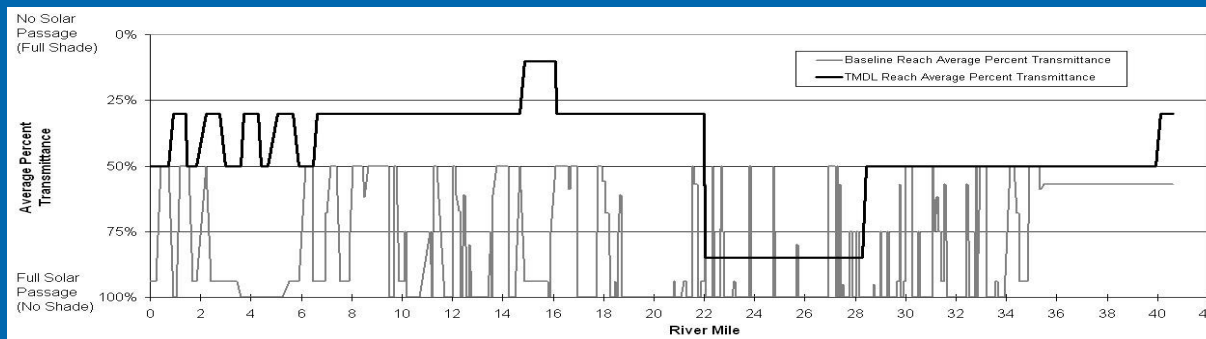


# Increased Flow Scenarios – Dissolved Oxygen Summary

- Effect of increased flows on maximum DO is mixed
- Effect of increased flows on minimum DO is also mixed
  - Largest increase in minimum DO of 0.4 mg/L at Freeman Lane due to 150% Big Springs Creek flow plus WQ compliance conditions
  - Largest decrease in minimum DO of 0.1 mg/L at Yreka-Ager Road due to 150% Big Springs Creek flow

# Temperature TMDL

- Potential solar radiation transmittance
  - Shasta River: reach-scale average solar radiation transmittance



- Tributaries: site potential riparian shade
- No net increase in temperature from tailwater return flows

# Dissolved Oxygen TMDL

Shasta River Dissolved Oxygen Load	Baseline Condition	Water Quality Compliance / TMDL Condition
Total Daily Production (lbs/day)	42,417	21,208
Total Daily Demand (lbs/day)	(21,308)	(12,702)

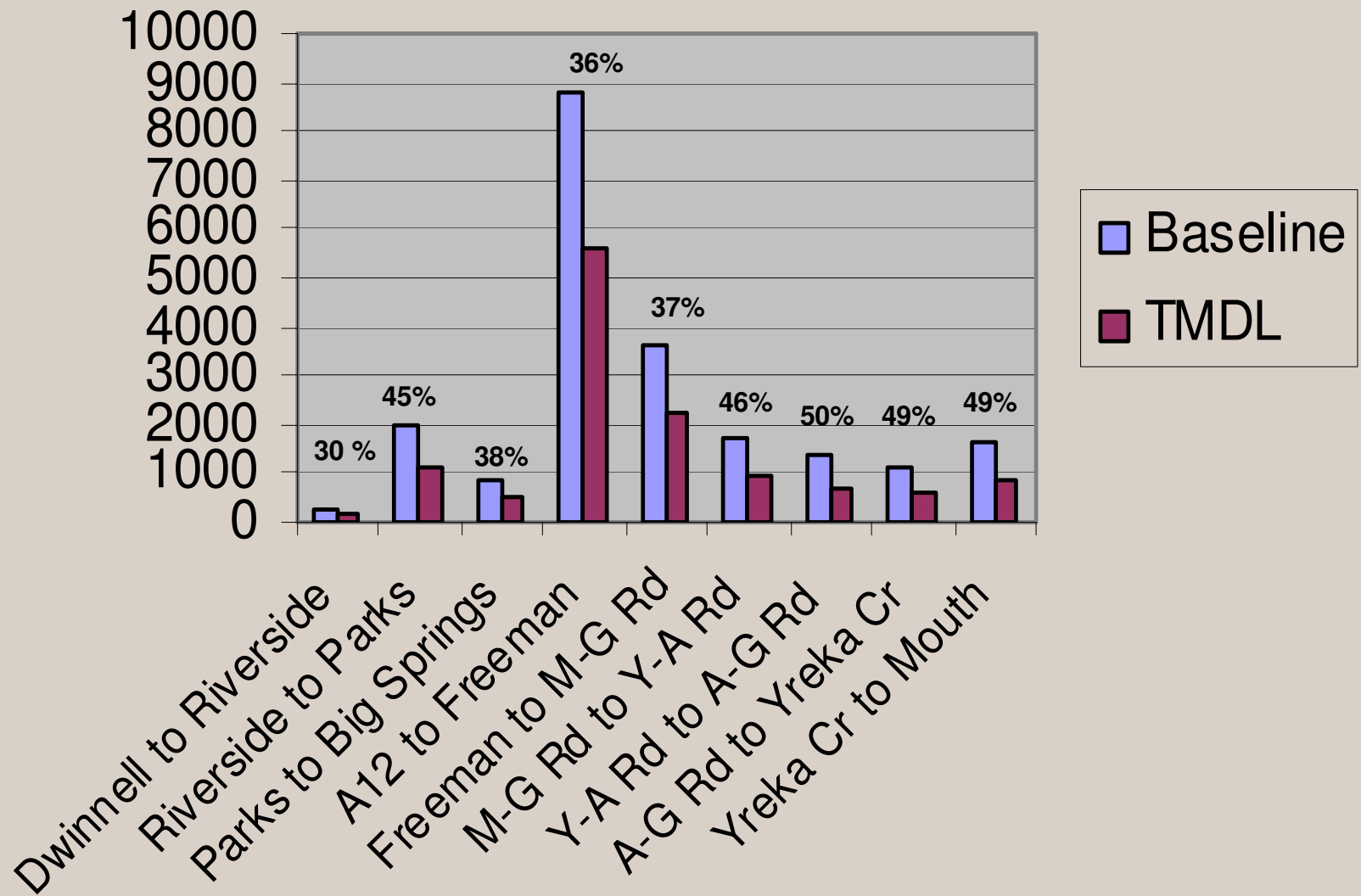
# DO TMDL continued

Dissolved Oxygen Process	Percent of Total Dissolved Oxygen Demand
Photosynthesis	0
Respiration	63
Carbonaceous oxygen demand	24
Nitrogenous oxygen demand	9
Sediment oxygen demand	4



# DO TMDL Load Allocations

Daily DO Demand (lbs/day)



# Questions?



# Shasta Watershed TMDL Draft Implementation Plan



# What is TMDL Implementation?

Steps and actions necessary to achieve the TMDLs and meet water quality standards.






# Shasta River Implementation Actions

## Main Points:

- Encourage and promote protection and restoration of riparian vegetation.
- Control nutrient and other oxygen consuming constituent waste discharges from human-caused sources.
- Encourage water management that improves water quality.

# Implementation Approach in the Shasta River

Identify, encourage, and build upon on-going restoration efforts that are linked to recovery of impaired waters and prevention of further degradation of water quality and beneficial uses.

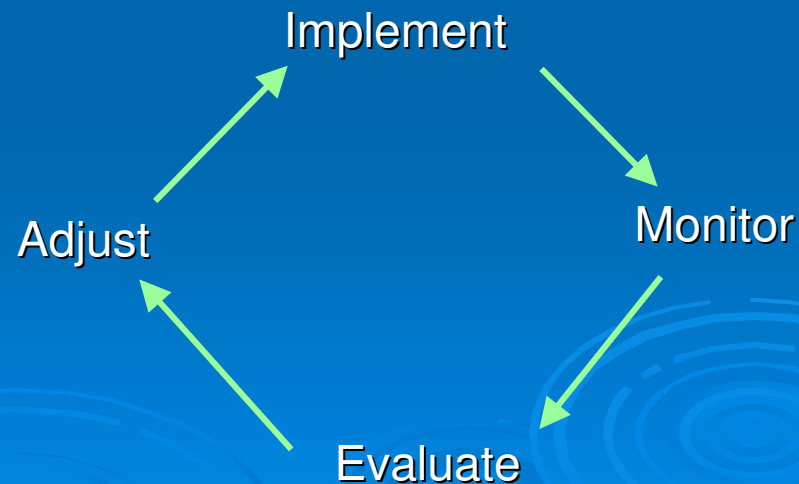
- Federal Agencies
  - Tribes
  - State Agencies
  - Local Agencies
  - Watershed Groups
  - Other Stakeholders
- 

# Implementation Approach in the Shasta River

- Identify gaps in on-going restoration efforts.
- Develop strategies with stakeholders to address those gaps.
- Continue existing permit programs.

# Implementation Approach in the Shasta River

- Use the iterative adaptive management process to make progress toward attaining and maintaining water quality standards.



# Implementation Approach in the Shasta River

## ➤ Attain TMDLs

- Likely to take 20, 30, to 40 years.
- ➡ Trend toward DO compliance.
- ➡ Trend toward temperature desired conditions.



# Regional Board Actions

## ➤ Permitting

- Nonpoint Source Policy
- 401 Certification
- Wastewater treatment permits
- Caltrans stormwater permit

## ➤ Enforcement

## ➤ Adaptive Management

# Grazing and Riparian Activities

- RWB encourages inventory, prioritization and repair of sources of nutrients and other oxygen consuming constituents & high water temperatures.
- RWB can require Grazing and Riparian Management Plans on an as-needed, site-specific basis.

# Water Management Activities

- Understand tailwater and runoff water conditions and effects
- Manage for water quality attainment
  - tailwater
  - impoundments
  - wastewater
  - stormwater runoff
- RWB can require Water Management Plans on an as-needed basis

# Timber Harvest Activities

## ➤ USFS

- Waiver
- MOU

## ➤ Private Timber


- Waiver
- General Permit

# Roads

- Caltrans Stormwater Permit



# Irrigation Districts and Divers

- Evaluate tailwater conditions, use, reuse, effects
  - Manage tailwater to improve water quality
  - Reduce water quality impacts of existing impoundments below Dwinnell Dam
  - Dwinnell Dam – RWB still evaluating implementation options
- 
- The background of the slide is a solid blue color. In the bottom right corner, there are several concentric white circles of varying sizes, resembling ripples on water, which serve as a decorative element.

# Private Landowners

- Grazing Management
- Water Management
- Vegetation Conservation and Restoration



# Shasta RCD, CRMP, NRCS, UCCE

- RWB shall work cooperatively with these organizations.
- RWB shall encourage:
  - implementation of the Shasta Restoration Plan.
  - assistance to landowners in developing and implementing nutrient and other oxygen consuming constituents and temperature control practices.

# Urban and Developed Areas

- Comply with existing permits, orders, and programs (Yreka, Montague and Weed)
- Assess nutrient and other oxygen consuming constituent loads from developed areas
  - stormwater runoff



# Timber Owners

- Use existing permits
- RWB shall work with Habitat Conservation Plan holders to develop ownership-wide Waste Discharge Requirements.



# Summary

- Implementation actions are designed to meet the DO and temperature TMDLs and achieve water quality standards.



# TMDL Schedule

- TAG meeting (Yreka) – November '05
- Interested Parties meeting (Eureka) – December '05
- Peer review of draft TMDL Report - November '05
- Public review of TMDL Report – February '06
- Regional Water Board and Public Workshops on TMDL (Santa Rosa, Arcata, and Yreka) – March '06
- Regional Water Board Hearing on TMDL (Ferndale) – May 2006
- State Water Board Workshop and Hearing on TMDL (Sacramento) – July/August 2006
- EPA approval of TMDL – January 2007
- TMDL implementation – February 2007

# Comments?

